would succeed without them. They were planted a year ago, just before the cold winter but survived and are sending up new leaves. It is too soon to judge whether they will thrive, but a report on these palms will be submitted at a later date.

One final bit of advice to palm enthusiasts in California. Most of our palms suffer from lack of water, as may be readily observed among the arecastrums *(Cocos plumosa)*. To help keep them moist be sure to build large saucers around them, encircled with six-inch mounds of clay to hold the irrigations. Then top the saucers with three inches of steer manure twice each season, and every other month add one-quarter inch of chicken manure, but do not work it into the soil. Just spread the well-rotted mulches on top of the soil and they will not burn.

Most palms seem to like a well-drained soil. All of ours, either tubbed or in the ground, seem to thrive in the following mix: one part clay, one part well rotted steer manure, one part leaf mold, one part sand, one part sponge rock. Our soil is rich but unfortunately heavy gummy adobe, so we prepare very large holes when using the above formula in planting.

When the old leaf bases of *Archontophoenix Cunninghamiana (Seaforthia)* become deciduous we have noticed the pinkish powder known as *Penicillium* fungus on two small plants. We are told that the force of rains can cause the fungus spores to jump several feet into the air and be carried to other palms by the wind. We cured one and will continue to spray the other with Phaltan every ten days until the fungus is no longer noticed. As a preventive we are adding a sticker-spreader liquid to the spray and spraying all other nearby palms.

This writer would like to read about the results of the experiments of many others in growing any kind of palm. The description of various climatic conditions, soils and amount of rainfall would be especially interesting. Hoping that our experiment may be a bit helpful, how about letting us hear about YOURS?

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Essays on the Morphology of Palms

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V. THE HABIT OF PALMS

The habit of a plant describes its general form and method of growth. Palms, with their terminal cluster of large leaves enclosing the single bud at the end of a slender unbranched stem, have such a distinctive habit that it is common to refer to unrelated plants with a similar appearance as "palm-like." This emphasizes the difficulty of including palms in the common subdivision of plants which admits of only herbs, shrubs and trees. Palms may be small but they are never truly herbaceous and they show various peculiarities in their mode of growth which makes it difficult to classify them as shrubs, trees or herbs. Palms, therefore, are best considered as a group of plants with a unique growth habit. However, this habit itself does vary considerably within the family as a whole. Thus the shape by which even a non-specialist recog-

nizes a palm may be exemplified by that of the coconut, royal palm or oil palm, but this only represents one of the growth forms which exist in the palms as a whole. It is the purpose of this article to indicate some of this diversity and also to show ways in which these forms are comparable.

Palms vary enormously in stature. The smallest palms resemble herbs. They possess slender stems of pencil thickness and only a few feet high. They are best exemplified by species of *Chamaedorea* (Fig. 45C) and *Reinhardtia*. The beginner could well be excused for not recognizing these diminutive plants as palms. On the other hand, palms like *Corypha*, *Jessenia*, *Jubaea*, and *Roystonea* have massive trunks which may exceed 100 feet in height. *Ceroxylon* is said to reach a height of 200 feet.

The general appearance of a palm depends to a large extent on the thickness and height of the stem, together with the way in which the stem branches, if at all. Each stem can be regarded as being made up of a number of discs or segments. Each segment is delimited by nodes, which represent the places of insertion of leaves, and consists of a single internode, which represents the distance between two successive nodes. Perhaps it is not too artificial a concept to regard the palm stem in this way, because the growth of each leaf is undoubtedly dependent upon the development of the internode immediately below and the overall growth of the stem can, in some ways, be regarded as a result of continual superposition of successive internodes with their associated leaves, one upon the other, although not in the disarticulate manner which this scheme might suggest. The leaves eventually fall or decay, but the stem segments persist.

The surface of the stem owes a great deal of its appearance to the degree of persistence, or otherwise, of the leaves, as I have indicated in the previous essay (Tomlinson, 1961). Thus, in many palms of the arecoid group, for which *Roystonea* serves as a familiar example, the leaf abscisses cleanly at the node below the crownshaft so that the stem is always smooth, with obvious internodes separated by ring-shaped leaf scars marking the nodes. In other palms, such as in *Phoenix*, the leaf base persists as a woody stump, the internodes are very short and the leaf scars are congested and overlap. The stem thus has a very irregular surface. There is much scope for simple but fundamental observation on the biology and structure of the leaf base in palms.

The distribution of leaves along the stem is one feature which may considerably influence the general appearance of a palm. This distribution is described by botanists as the phyllotaxy of a plant. The phyllotaxy in palms is usually spiral. In *Neodypsis* and *Chrysalidocarpus* the spiral is represented numerically as 1/3, because there are only 3 vertical series of leaves. This, however, is unusual and the spiral is usually much tighter, including many series of leaves. Occasionally the successive leaves are inserted, not along a spiral, but distichously, the leaves being arranged alternately in two opposite ranks along the stem. This produces a very striking appearance as in *Wallichia disticha*, *Oenocarpus distichus* and in some scandant palms.

The general habit of a palm depends, however, not so much on the distribution of leaves on the stem as on the overall length which the stem may attain, together with its method of branch-

ing. On this basis a few very distinct habit-forms can be recognized.

Stems Solitary

The stem is erect, columnar and always unbranched at the base. It represents the habit recognized by the layman as "palm-like." In larger palms of this type the stem may be several feet in circumference, cylindrical and very imposing, as in *Jubaea*, *Roystonea* (Fig. 45A) or *Phoenix canariensis*. It often rests on a wide dilated base which appears early in the development of the palm and serves mechanically as a solid foundation, useful if such palms are to achieve a great stature (Tomlinson, 1960). Many other palms have the same habit, but the stems are more slender and not usually so tall and there is a gradual transition from such forms as *Cocos*, by way of *Dictyosperma*, *Ptychosperma* and *Veitchia* to small palms such as *Geonoma*, *Hyospathe* and *Pinanga* down to the single-stemmed species of *Chamaedorea*.

Palms of this type of habit do not necessarily grow vertically upwards. Coconut palms commonly have curved trunks whilst *Opsiandra* may have reclining stems in certain situations.

The stilt palms are a group which essentially have solitary stems, but afford a distinctive habit (Tomlinson, 1960). Palms of this group are unusual in that they grow rapidly in length during the seedling stage and the early internodes are narrow. This unstable axis is supported by thick, buttressing stilt roots (Fig. 45F).

Single-stemmed palms may branch abnormally, as when the terminal bud is damaged mechanically or by disease. *Hyphaene*, however, does possess a unique habit, because in several of its species the stem bifurcates, or dichotomizes, at regular intervals in a very striking and characteristic way (Fig. 45B).

Stems Numerous

Some palms have the ability to increase the number of their stems by means of suckers arising in the axils of the basal leaves. Palms of this habit are variously described as tufted or clustered and botanists may use the word caespitose or soboliferous. Normally the suckers grow out close to the base of the parent stem so that the palm is truly tufted, as in *Ptychosperma Macarthurii* or in *Phoenix reclinata* (Fig. 45D). However this leads to competition between different shoots from the same individual. In some palms this is avoided because the sucker grows horizontally away from the parent stem before developing an erect shoot. This occurs, for example, in species of *Bactris*, *Chamaedorea* and *Metroxylon*. *Rhapis* will adopt this spreading habit in loose sand, but tends to be more tufted when pot-grown. Since these palms are capable of spreading over a wide area by purely vegetative means, they may be said to be colonial (Fig. 45H).

It should be noted that, except in abnormal circumstances, buds in tufted palms are always restricted to the base of the aerial stems. The aerial stems themselves are always unbranched and otherwise resemble the trunks of single-stemmed palms without, however, reaching the same height. *Euterpe* and *Oncosperma* are rather exceptional because the individual stems may be quite tall.

The type of stem, whether clustered or solitary, is almost invariably constant for each species of palm. On the other hand both the single-stemmed and caespitose conditions may occur within a single genus, as in *Areca*, *Arenga*, *Caryota*, *Euterpe*, *Ptychosperma*, *Phoenix*

and *Raphia*. This may be because single-stemmed species have evolved from caespitose types by the loss of the basal suckers, as has been suggested by Holttum (1955), the process having occurred independently in many genera. The mechanism by which suckers are produced is not understood, but to be able to control suckering in a palm would have enormous practical benefit. Palms which sucker are easily propagated. Single-stemmed palms have to be grown from seed and, apart from the time this involves, this makes it difficult to maintain selected varieties. There are many more varieties of date palm, which is propagated by suckers, than there are of either coconut or oil-palm, both of which are propagated by seed.

Stems Subterranean

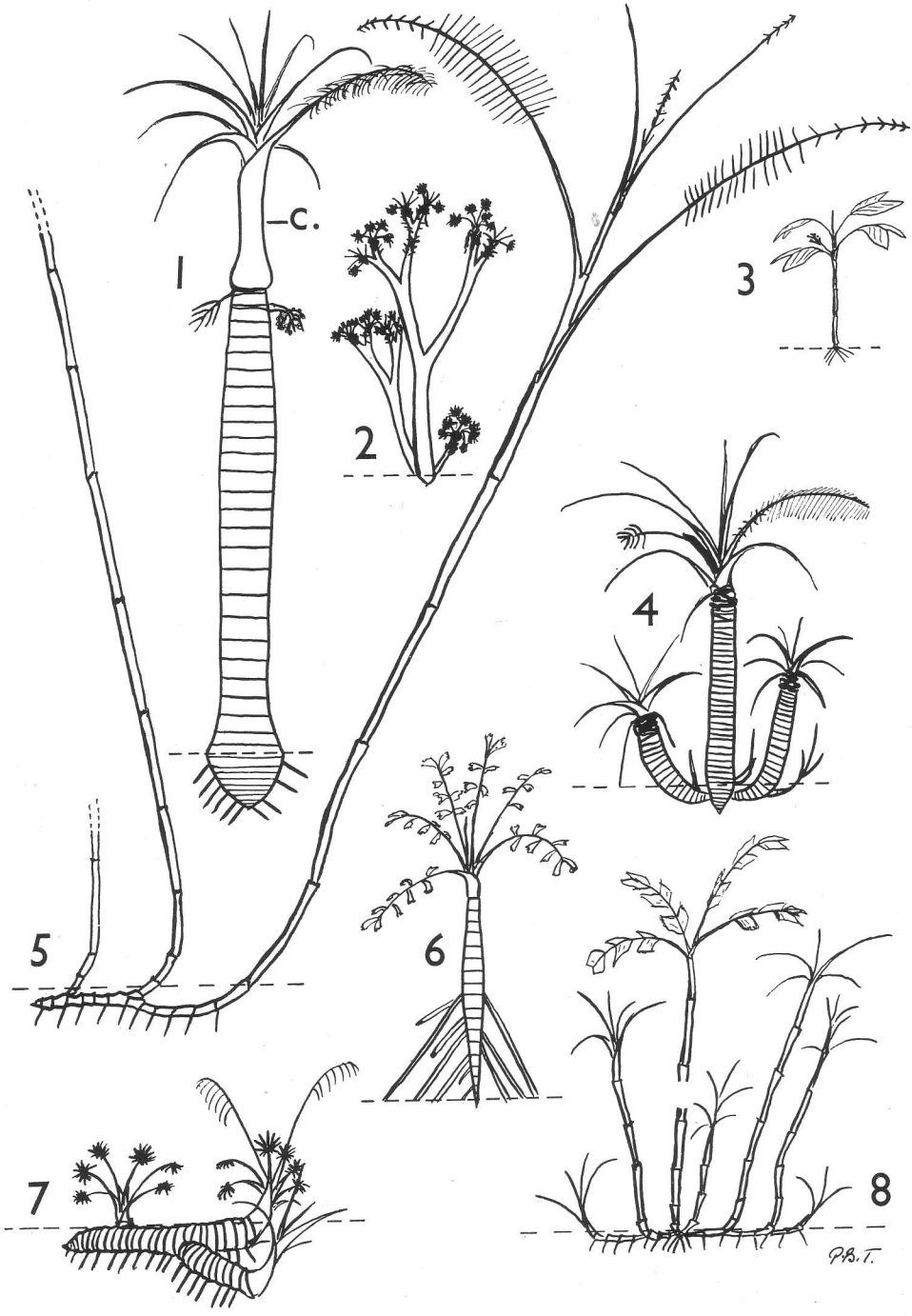
Although we recognize a palm by its distinctive aerial stem, a number are known in which the trunk remains wholly underground since it grows horizontally and not erect (Fig. 45G). Such palms are sometimes described as stemless or "acaulescent" (e.g. *Phoenix acaulis*), although the stem is not absent, but merely invisible. The best example of this habit is shown by *Nypa*, the stem creeping in estuarine mud so that only the leaves, erected by unequal growth at the leaf base, become visible. In *Nypa* the stem is branched. Other palms may be similar as in *Salacca*, but *Phytelephas* and *Sclerosperma* have underground stems which are unbranched. These latter also tend to grow more or less erect, but so slowly as to remain almost wholly buried. Several genera which are familiar as tall growing species also include one or more species which are depauperate relatives with underground stems. Familiar examples are *Sabal Etonia* and *S. minor*, *Phoenix acaulis* and *Syagrus flexuosa*. Other small palms may be less obligate in their growth form. Thus *Serenoa repens* in burned-over pinelands has a creeping stem, but sometimes if disturbed or grown in favourable situations it will produce a tall erect stem. *Chamaerops humilis* in cultivation often belies its specific name and develops erect stems like a typical tufted palm.

Stems Climbing

The rattans or climbing palms of the Eastern tropics are familiar to travellers in the Malay Archipelago. However, such scandent palms can be seen in all parts of the tropics and the habit seems to have evolved independently in at least five groups. Features which diagnose this growth habit are the long slender aerial stems, the narrow, cane-like internodes, often reaching a length of several feet, while the stem as a whole may reach an overall length of several hundred feet, being supported by various devices which enable the crown to grow into the forest canopy. The biological advantages of this growth habit in the tropical rain forest are obvious.

The scandent aerial stems usually arise from underground rhizomes so that the palms are basically tufted or somewhat colonial (Fig. 45E). The habit is most conspicuously developed in the lepidocaryoid palms. The construction of the slender stems is always the same, but their grapnel-like supports are not all identical. This is evidence that all climbing palms are not equally related. *Calamus* shows unique morpho-

45. Growth habits in palms (not to scale). A, stem solitary, columnar, e.g. *Roystonea* (c—crown-shaft); B, aerial stem dichotomizing, e.g., *Hyphaene* sp.; C, stem slender, canelike, e.g., *Chamaedorea* sp.; D, stems tufted, e.g., *Phoenix* sp.; E, aerial stems climbing, leaves of *Ancistrophyllum* or *Desmoncus* type; F, stilt palm, e.g., *Iriartea;* G, stems creeping, subterranean, e.g. *Sabal Etonia;* H. colonial palms, e.g. *Bactris* sp.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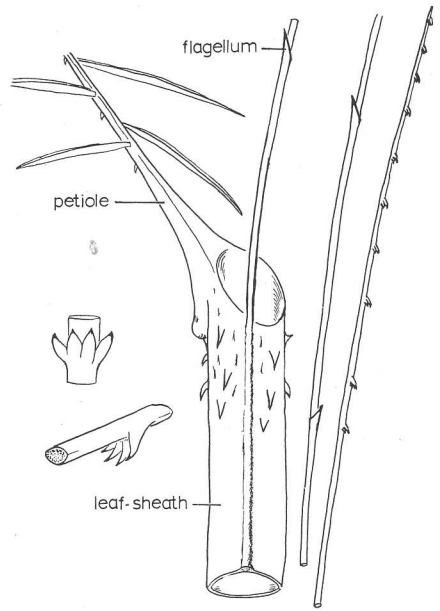
logical features which have given it considerable advantages in producing new forms. The genus includes some 300 known species. Most of these are supported by modified inflorescence branches. These are normally unbranched whiplike organs called flagella and they bear distal grapnel-like claws. Each flagellum is peculiarly disposed since it apparently arises from the side of the leaf sheath. These organs are, however, truly axillary, but each is fused to the internode and most of the leaf sheath above its node of origin (Fig. 46). That these are equivalent to inflorescences is made obvious by comparative study. The inflorescence in *Calamus* has the same peculiar mode of attachment as the flagellum, commonly terminating in clawed appendages, and there are all transitions between flagella and inflorescences (Furtado, 1958). Commonly the flagellum also bears small spathe-like organs which can only be interpreted as reduced bracts.

All other climbing palms are supported by cirri which are prolongations of the leaf rachis as previously described (Tomlinson, 1961). Such palms therefore constitute a second distinctive biological group, but not a taxonomic one, since palms with this habit occur in quite unrelated tribes and in different parts of the world. Also their leaf morphology is not wholly identical. Thus the scandent lepidocaryoid palms of the Eastern tropics, which include genera like *Daemonorops, Korthalsia* and *Plectocomia,* have evolved independently of the African climbing palms, *Ancistrophyllum, Eremospatha* and *Oncocalamus,* although they belong to the same subfamily. The former genera have clawed appendages arranged along their cirri, whereas the latter have pairs of backwardly-directed spines which are modified leaflets (Fig. 45E). In the



46. Leaf morphology in *Calamus.* Upper part of tubular leaf sheath with laterally attached flagellum, this, with three reduced bractlike organs, drawn in three separate parts. Insets show distal claws (ungues) from two aspects and enlarged.

American tropics similar modified leaflets occur on the cirri in *Desmoncus* and a few species of *Chamaedorea.* These two genera are, however, quite unrelated. The scandent species of *Chamaedorea* are the least specialized of all the scandent palms and differ little from certain related *Chamaedorea* species which have a straggling habit. These transitional forms suggest the way in which the scandent habit has evolved.

From this brief account it will be gathered that palms show more diversity in their growth form than is generally realized. This diversity represents elegant variation on a basic theme, the theme being best represented by the tufted palm. This basic type may also be primitive, and the various modifica-

tions described above, in producing new forms, have allowed new habitats to be explored.

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Linospadix monostachya – An Attractive Australian Ornamental

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To palm enthusiasts with limited space for gardening, dwarf species are always of interest. *Linospadix monostachya* (Mart.) H. Wendl, is just such a dwarf palm. The writer first observed this species in 1958 growing in state botanic gardens at Melbourne and Sydney, the only two cities of the continent "down under" that have outstanding palm collections. It is an unfortunate fact that Australian horticulture still makes but rather limited use of the wide range of ornamental material available in the palm family and this is well illustrated by the present species, which is known solely as obscure specimen plants in the botanic gardens mentioned.

Linospadix monostachya, which sometimes passes incorrectly under the later name *Bacularia monostachya,* is a native of Australia ranging from northern New South Wales into Queensland. As can be seen from the illustrations this is a slender palm with stems from 1 to 1½ inches in diameter. Plants in cultivation average about 5 feet tall, but undoubtedly they attain greater heights in nature. Numerous 2- to 3-foot-long interfoliar flowering spikes were present during October (which is mid-spring in Australia). These arch gracefully out from the axils of attractive dark green pinnate leaves. The inflorescences in this genus are also characterized by the presence of a tubular bract at the base of the spike, similar to that found in the New World genus *Calyptrogyne.*

The dark green foliage, slender habit, and diminutive size are indications that *Linospadix* is an understory palm of moist woodland or forest. In cultivation it apparently thrives best in partial to full shade and in this respect is similar in its cultural needs to such New World genera as *Chamaedorea* and *Geonoma.* Because of its obvious ornamental merit, seed of *Linospadix* was subsequently obtained through the courtesy of the Director of the Melbourne Garden and as a result the establishment of this rare species in the New World has been assured. According to De Leon (in *Principes* 2:96. 1958) the seeds of this genus, which are the size and shape of wheat grains, are very short-lived, remaining viable only for periods of from two to three weeks, after which germination falls off sharply. At Longwood Gardens, fresh seed sown in sand and